United States Patent [19]

Blandford

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[45] **May 8, 1984**

[54] **COUPLING WITH OVERLOAD PROTECTION**

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[52] **U.S. Cl.** **464/32**; 403/2

[58] **Field of Search** 464/30, 32, 33; 403/2, 403/DIG. 3

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Assistant Examiner—Daniel P. Stodola

Attorney, Agent, or Firm—Gary M. Gron; Robert T. Ruff

[57] **ABSTRACT**

An overload protection coupling for limiting the torque transmitted between two elements of a rotating power transmission system comprises coaxial driving and driven members journalled for relative rotation. The members are drivingly connected to each other by one or more rod-like tensile breaking piece devices effective between first pairs of radial projections on the driving and driven members. One or more reaction devices are effective between second pairs of radial projections on the driving and driven members to ensure that the rod-like breaking piece devices are in pre-tension to a predetermined level approximately equivalent to the maximum torque transmitted by the coupling to increase fatigue life of the breaking piece devices. In some embodiments, the tensile breaking piece devices and reaction devices may be effective between just one pair of radial projections.

1 Claim, 11 Drawing Figures

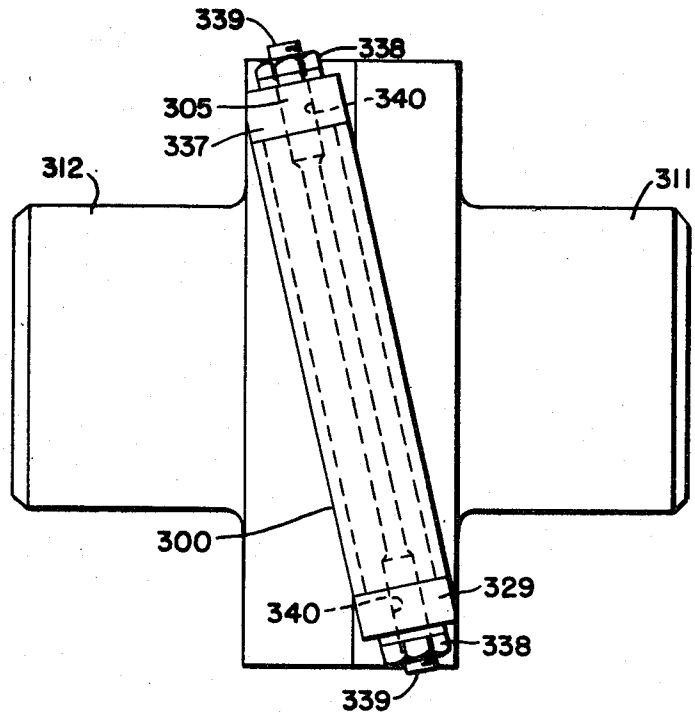


FIG-1

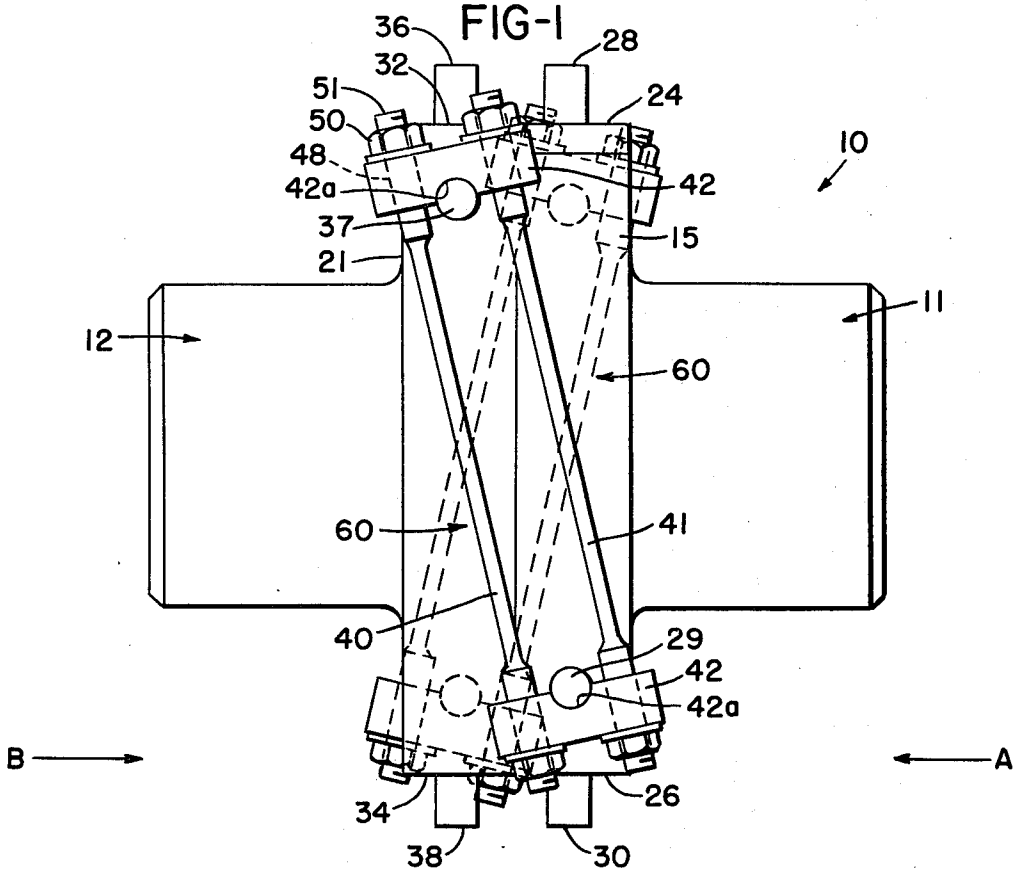

36
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32
51
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42a
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37
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11
12
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42a
B
A
34
26
38
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FIG-2

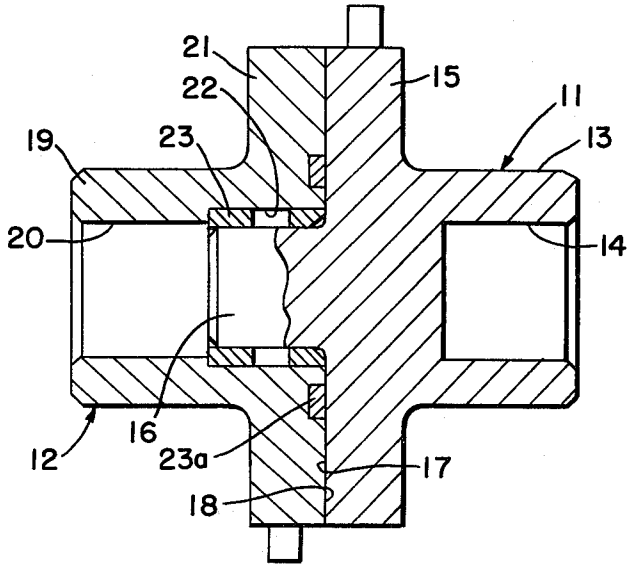

21
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22
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14
16
12
23a
17
18

FIG-3

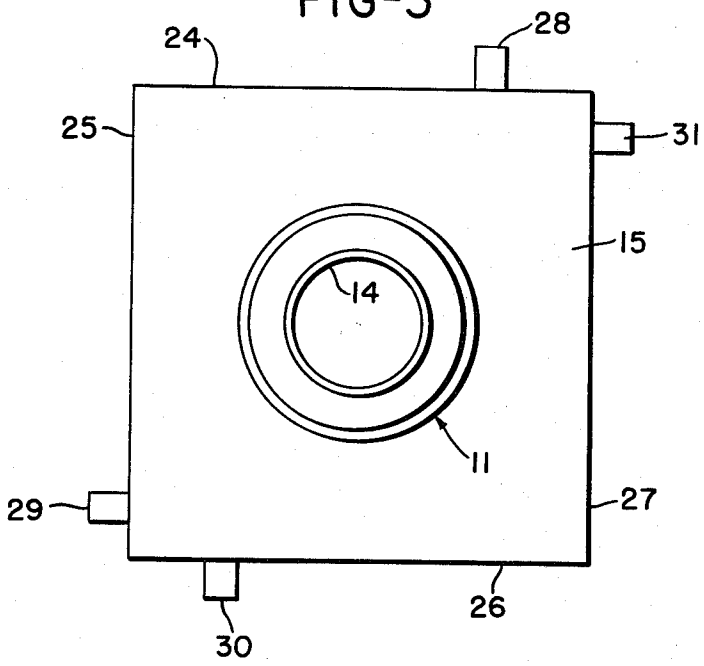


FIG-4

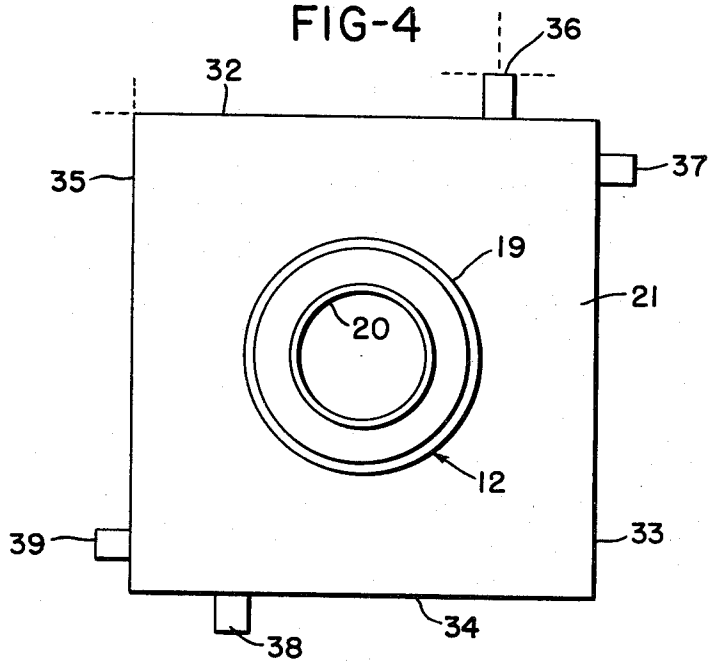


FIG-5

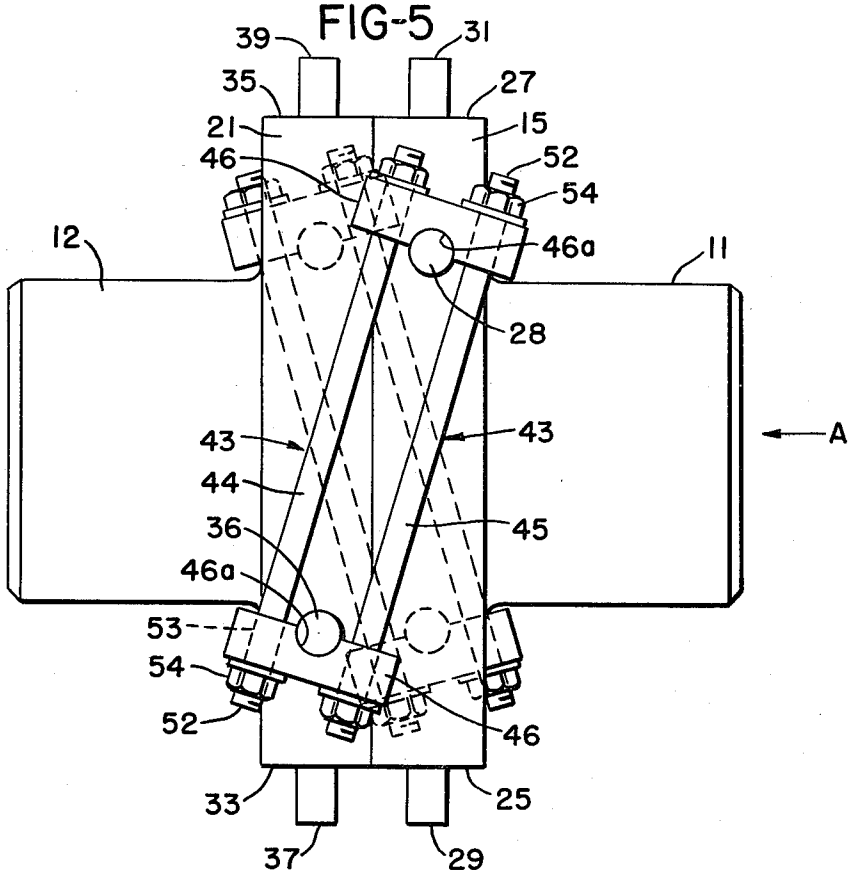

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12
46a
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46a
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37
29

FIG-6

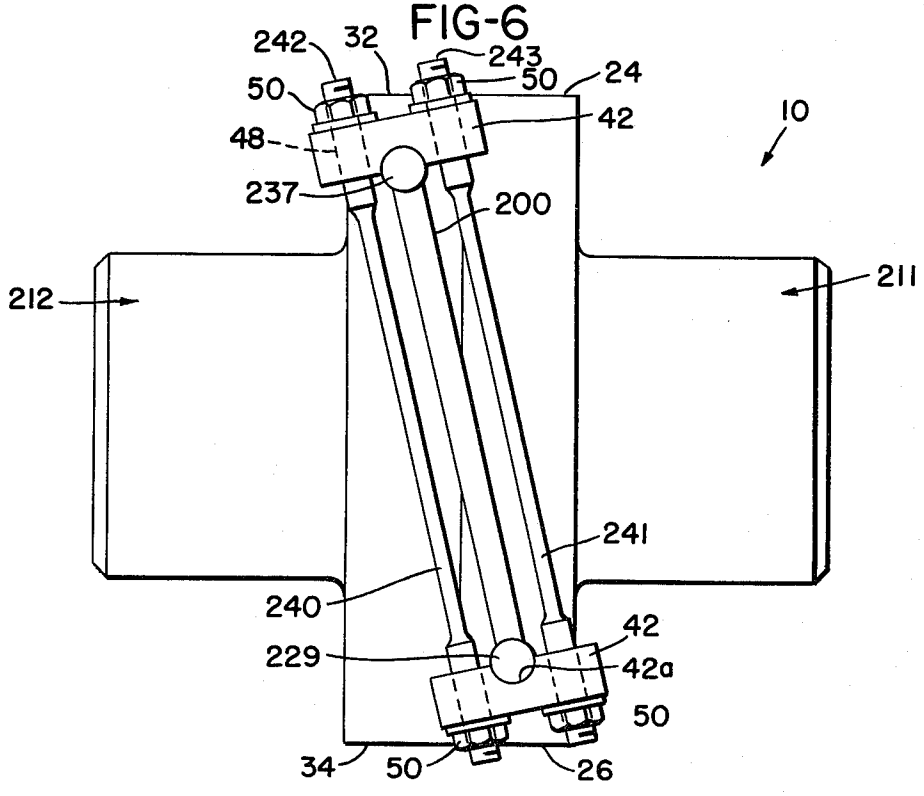

242
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243
50
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48
237
200
212
211
241
240
42
229
42a
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34
50
26

FIG-7

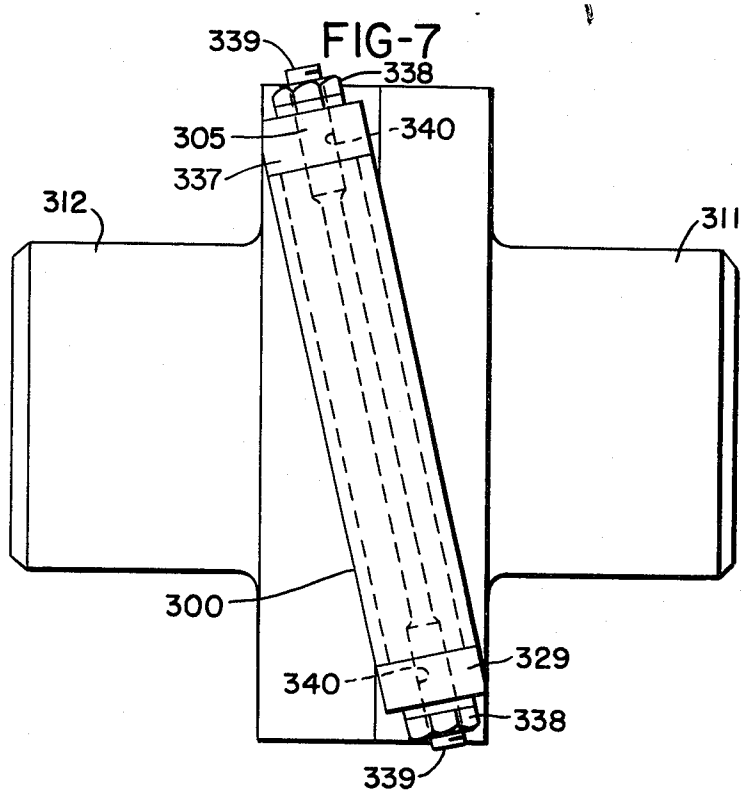

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305
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311
300
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338
339

FIG-8

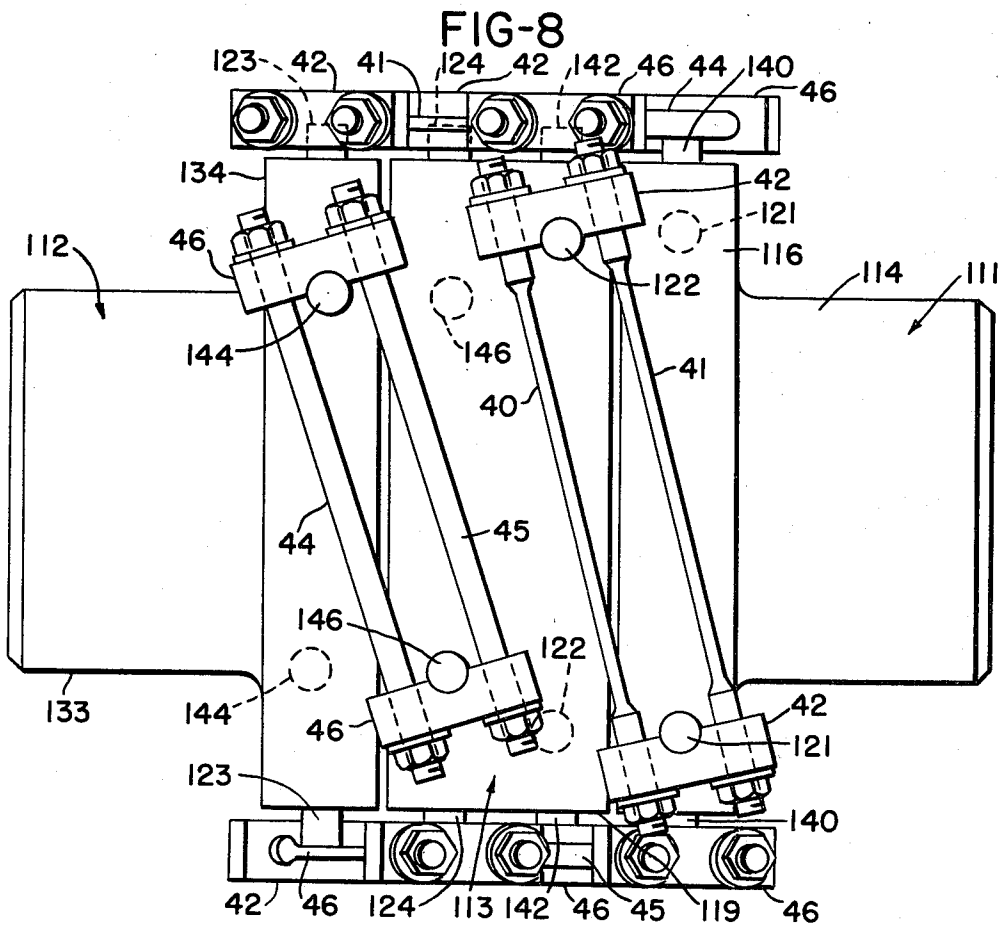

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119
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FIG-9

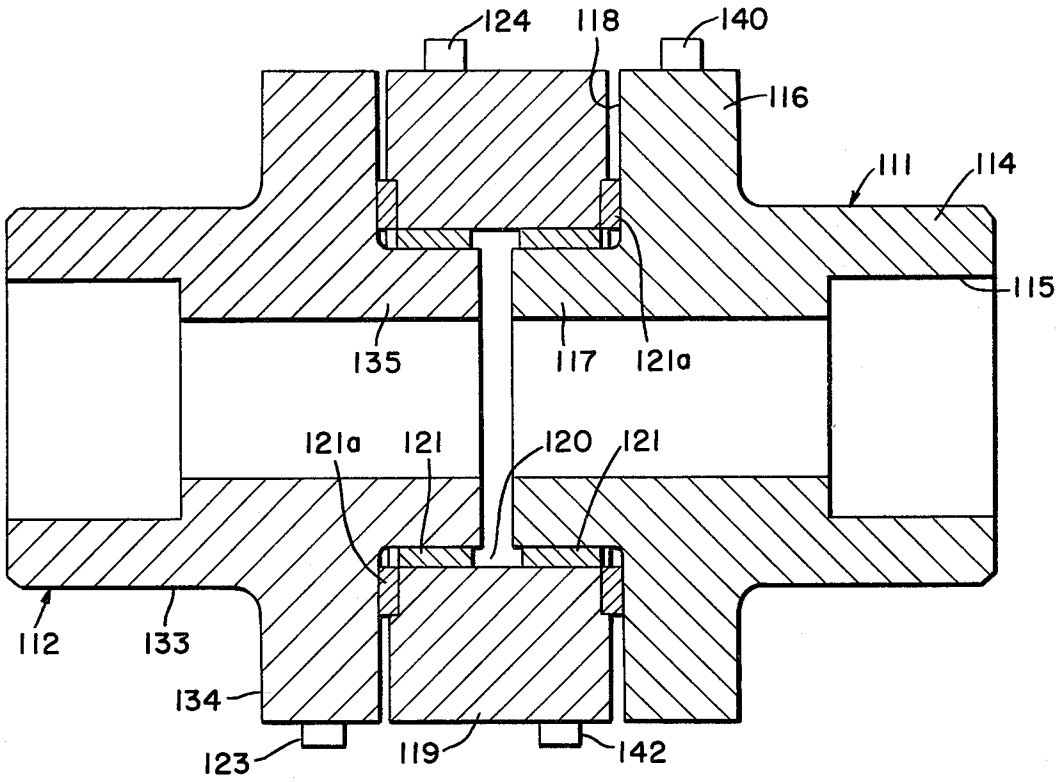
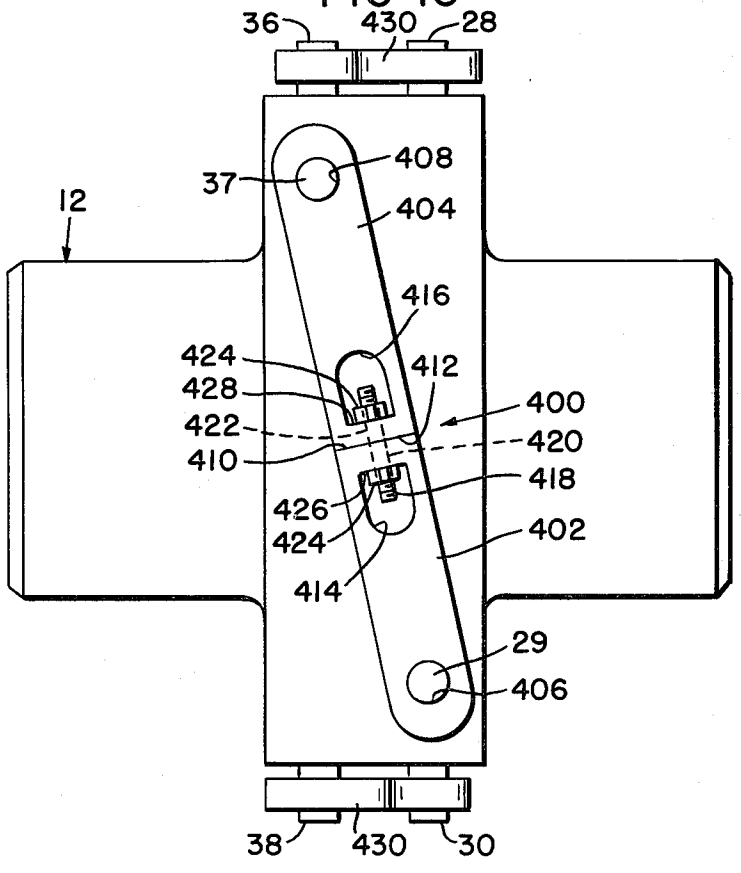

124
118
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121a
121a
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FIG-10


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402
414
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406
38
430
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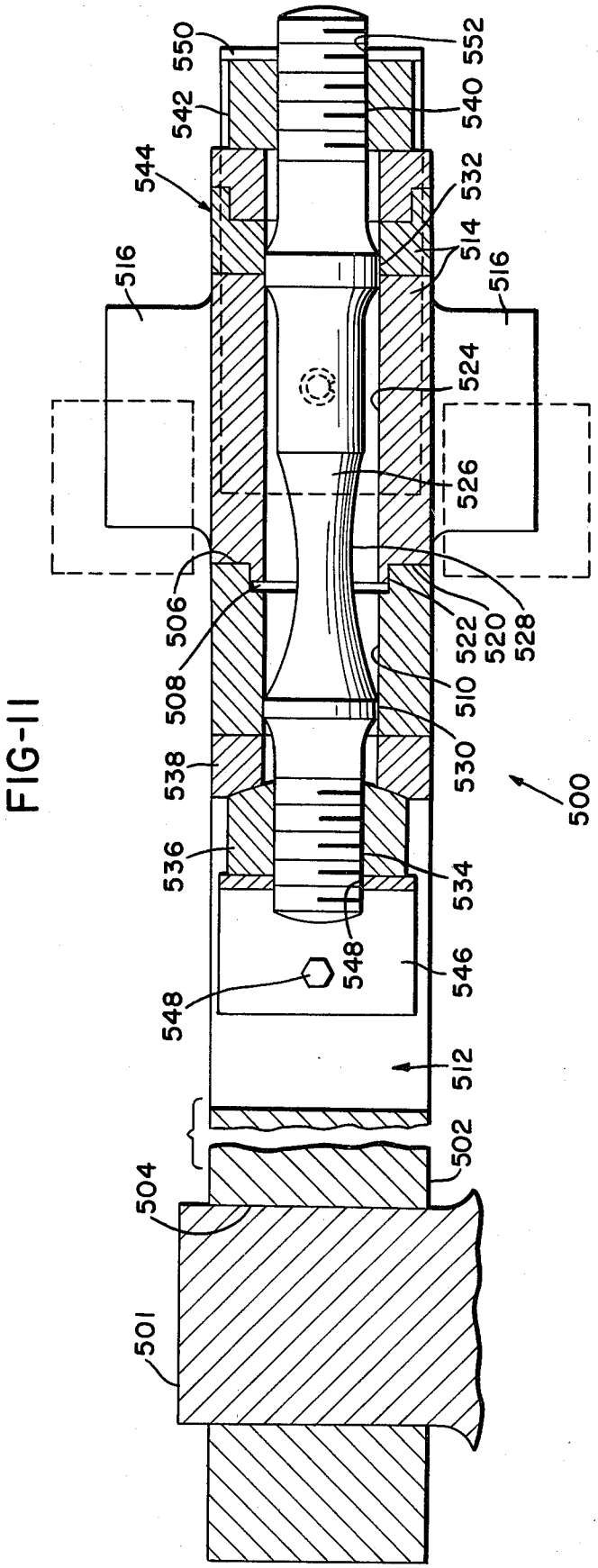

550
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500
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546
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512
502
504
501

FIG-11

COUPLING WITH OVERLOAD PROTECTION

The present invention relates to overload protection devices and in particular to an overload protection coupling for controlling, to a predetermined maximum, the torque transmitted between two elements of a rotating power transmission system.

The use of overload protection devices used for transmitting torque between two elements of rotating machinery is well known. Frequently, such devices include a pin dimensioned (for example by notching) to shear when the torque transmitted between the two rotating machine elements imposes a predetermined shear stress on the pin. One such device is illustrated and described in British Pat. No. 1,520,416. More complex devices have also been used for overload protection between rotating machine elements. British Pat. No. 1,512,846 discloses such a device in which the driving and driven halves of the overload protection coupling have integral abutting semi-cylindrical radial extensions which form cylinders embraced by hardened steel rings. When the driving torque exceeds a set limit, the rings snap or break to protect the elements connected to the coupling.

A major disadvantage with such previous overload protection couplings is the difficulty in designing the breaking pieces so that they have an acceptably long working life when the coupling is installed in a power transmission system that is subject to torque fluctuations and possible torque reversal. Where the breaking pieces are designed to fail at a torque that is slightly above the maximum normal torque being transmitted by the coupling, the stress in the breaking pieces fluctuates in proportion to the torque fluctuation in the power transmission system from a value approaching the breaking stress of the breaking piece material down to zero stress, and in some instances, to a complete reversal of the direction of the stress. This repeated stress fluctuation drastically reduces the fatique life of the breaking piece which can fail when the coupling is transmitting a torque below its designed maximum value. If the breaking pieces are designed to fail at a torque that is considerably higher than the normal maximum torque transmitted by the coupling the fatique life of the breaking piece can be improved but this, however, necessitates that larger factors of safety be used throughout the power transmission system as a whole and hence the component parts become more expensive.

In accordance with the present invention the above problems are solved by an overload protection coupling for limiting the torque transmitted between two elements of a rotating power transmission system, comprising coaxial driving and driven members journalled for rotation relative to each other. The members are drivingly connected to each other by one or more tensile breaking piece devices, spaced around the periphery of the overload protection coupling, each device including at least one tensile breaking piece, and one or more devices for pre-tensioning the tensile breaking pieces up to a value at least equal to the tensile stress resulting from the force applied to the breaking piece by the maximum normal torque transmitted by the coupling.

The above and other related features of the present invention will be apparent from a reading of the following description of the disclosure shown in the accompanying drawings and the novelty thereof pointed out in the appended claims.

FIG. **1** is a side elevation of a first overload protection coupling embodying the present invention;

FIG. **2** is a sectioned side elevation of the coupling of FIG. **1** without the breaking and loading pieces;

FIG. **3** is an end elevation of the coupling in the direction of arrow A in FIG. **1** without the breaking and loading pieces;

FIG. **4** is an end elevation of the coupling in the direction of arrow B in FIG. **1** without the breaking and loading pieces;

FIG. **5** is a plan view of the coupling of FIG. **1**;

FIG. **6** is a side elevation of a second overload protection coupling illustrating an alternate embodiment of the present invention;

FIG. **7** is a side elevation of a third overload protection coupling illustrating another embodiment of the present invention;

FIG. **8** is a side elevation of a fourth overload protection coupling illustrating still another embodiment of the present invention; and

FIG. **9** is a sectioned side elevation of the coupling of FIG. **8** with the breaking pieces and loading pieces removed;

FIG. **10** is a side elevation of still another overload protection coupling embodying the present invention; and

FIG. **11** is a longitudinal section view of an alternate breaking link assembly which embodies the present invention.

Referring now to FIGS. **1** to **5** of the drawings, in which like elements are given like reference numerals, an overload protection coupling is generally designated **10** and comprises a driving member **11** and a driven member **12**. The driving member **11** comprises a hub portion **13** having a bore **14** for connection to a driving shaft (not shown). A rectangular flange **15** is co-axial and integral with the hub portion **13** and a cylindrical portion **16** is coaxial with and projects from face **17** of the rectangular flange **15**.

The driven member **12** comprises a hub portion **19** having a bore **20** for connection to a driven shaft (not shown), and a rectangular flange **21** coaxial and integral with the hub portion **19**. The driven member includes a bore **22** provided with bearings **23** which cooperate with the cylindrical extension **16** of the driving member to provide journal bearing support for relative rotation between the driving member **11** and the driven member **12**. Thrust bearings **23***a* may additionally be provided between the opposing faces **17** and **18** of the two coupling members.

The rectangular flange **15** of the driving member **11** and the rectangular flange **21** of the driven member **12** are similarly sized and arranged so that the peripheral faces of one are coplanar with the peripheral faces of the other. It should be noted, however, that the flanges **15, 21** may be provided in a form other than rectangular and still enable the beneficial qualities of the present invention.

The peripheral faces **24, 25, 26, 27** of the flange **15** (FIG. **3**) are provided with cylindrical projections **28, 29, 30, 31** spaced as illustrated. Similarly, the peripheral faces **32, 33, 34, 35** of rectangular flange **21** are provided with cylindrical projections **36, 37, 38, 39** (FIG. **4**). The projections may be machined integrally with the flanges **15** and **21** or may be separate pieces attached by force fitting or other means into suitably sized holes in the peripheral flange faces.

The driving connection between the driving member **11** and driven member **12** is provided by two pairs of tensile breaking piece devices **60**. In one device **60**, a pair of tensile breaking pieces **40, 41** (FIG. **1**) connects, by means of arcuate recesses **42***a* in bridge pieces **42**, projection **29** on face **25** of rectangular flange **15** to projection **37** on face **33** of rectangular flange **21**. Projections **31** and **39** on faces **27** and **35** respectively are similarly connected by a second pair of tensile breaking pieces on the other tensile breaking piece device **60**. The breaking pieces are fixed in position by passing threaded ends **51** of each tensile breaking piece through suitably sized holes **48** in the bridge pieces **42** and locking them in position with nuts **50**.

Spaced alternately with the tensile breaking piece devices **60** are a pair of reaction devices **43** (FIG. **5**). In one device **43**, a pair of tensile reaction members **44, 45** connect, by means of arcuate recesses **46***a* in bridge pieces **46**, projections **28, 36** on faces **24,32** respectively of rectangular flanges **15** and **21** respectively. Similarly, projections **30, 38** on faces **26, 34** are connected by a second pair of reaction members in the other reaction device **43**. The reaction members **43** are similarly fixed in position by passing threaded ends **52** of each tensile reaction member through suitably sized holes **53** in the bridge pieces **46** and locking them in position with nuts **54**.

In the coupling illustrated in FIGS. **1** to **5** the tensile breaking pieces are arranged relative to the rectangular flanges so that flange **15** is urged in a clockwise direction relative to flange **21** as viewed in the direction of arrow A in FIG. **1**. The reaction members are positioned to urge flange **15** in an anti-clockwise direction relative to flange **21** as viewed in the direction of arrow A of FIG. **5**. The reaction members, spaced alternatively with the tensile breaking pieces around the periphery of the coupling, are therefore loaded in tension to provide the means for pretensioning the tensile breaking pieces. Although the tensile breaking pieces and corresponding reaction members are shown in sets of two on alternating faces of the rectangular flanges **15, 21** it should be apparent that they be employed in different numbers of sets.

The above design of tensile reaction member, may, however, be readily replaced by a compression reaction member located between any two projections connected by a pair of tensile breaking pieces and loaded in compression to provide the means of pre-tensioning the tensile breaking pieces.

FIG. **6** illustrates one such arrangement of tensile breaking piece and reaction member in which the compression reaction member **200** is located between a projection **229** on the driving member **211** and a projection **237** on the driven member **212**, the projections being connected by a pair of tensile breaking pieces **240, 241** extending through bridge pieces **42** and locked in place by nuts **50** on threaded end portions **242, 243** on pieces **240, 241** respectively.

FIG. **7** illustrates an alternative arrangement to that of FIG. **6** in which a tubular reaction member **300** is located between a projection **329** on driving member **311** and a projection **337** on driven member **312**. A single tensile breaking piece **305** is telescoped into the reaction member **300**. Tensile breaking piece **305** connects projections **329** and **337** in tension by means of nuts **338** retained on threaded end sections **339** extending through holes **340** in projections **329, 337**.

In operation of the foregoing couplings the normal torque fluctuation is divided between the tensile breaking pieces and the reaction members in proportion to their respective contributions to the total torsional stiffness of the connection between the coupling driving and driven members as long as the breaking pieces are pre-tensioned against the reaction members. The greater the total torsional stiffness of the connection (by the combination of tensile breaking pieces and reaction members) between the driving and driven members, the smaller will be the resultant strain fluctuation in the breaking pieces as long as the breaking pieces are pretensioned against the reaction members. The contribution of the breaking pieces to the total torsional stiffness of the connection is limited by the cross-sectional area dictated by the designed breaking stress and by the length required to ensure substantially tensile loading and to minimize bending stresses in the tensile breaking pieces created by the angular displacement of the projections relative to the axis of rotation of the coupling. Preferably the reaction members are arranged to provide a greater contribution to the total torsional stiffness than the breaking pieces. This may be achieved by adjusting one or a combination of parameters associated with the reaction members such as cross-sectional area, length, effective radius between reaction member and coupling rotational axis or number of reaction members.

Where the torsional stiffness of the reaction members is substantially greater than the torsional stiffness of the breaking pieces, the transmitted torque at which the reaction members would fail under reverse torque loading or reverse rotation would be substantially greater than the transmitted torque at which the tensile breaking pieces would fail when the coupling is rotating and transmitting torque in the normal or forward direction of rotation. Under conditions of torque reversal or reverse rotation the tensile breaking pieces will become loose before the reaction members fail.

The invention, as applied to the couplings illustrated in FIGS. **1** to **7**, is generally suitable for transmission systems where breaking pieces are provided to fail in one direction of rotation only. FIGS. **8** and **9** illustrate an adaptation of the coupling in which breaking pieces are provided to fail in both directions of rotation.

The coupling illustrated in FIGS. **8** and **9** comprises a driving member **111** and a driven member **112** spaced by an intermediate coupling member **113**. The driving member **111** comprises a hub portion **114** having a bore **115** for connection to a driving shaft not shown, a rectangular flange **116** and a cylindrical portion **117** co-axial with and projecting from face **118** of the rectangular flange **116**. The driven member **112** is identical with the driving member **111** and comprises a hub portion **133**, a rectangular flange **134** and a cylindrical portion **135** coaxial with and projecting from face **136** of the rectangular flange **134**. The intermediate member **113** comprises a rectangular portion **119** having a bore **120** provided with bearings **121** which cooperate with the cylindrical portions **117, 135** respectively on the driving and driven members **111, 112** to provide journal bearing support for the relative rotation of the three members **111, 112** and **113** with respect to each other. Thrust bearings **121***a* may be provided between the opposing faces of the driving member and intermediate member and the intermediate member and the driven member.

The rectangular flanges **116** of the driving member **111**, the driven member **112** and the rectangular portion **119** of the intermediate member **113** are similarly sized

and the peripheral faces of each rectangular flange **116**, **134** and the rectangular portion **119** are coplanar with each other.

In a manner similar to the coupling illustrated in FIGS. **1** to **5**, radial projections **121** on the rectangular flange **116** of the driving member **111** are connected to a first set of radial projections **122** on the intermediate member **113** by pairs of tensile breaking pieces **40**, **41** and bridges **42**. Similarly, radial projections **140** on the rectangular flange **116** of the driving member **111** are connected to a second set of radial projections **142** on the intermediate member **113** by pairs of reaction members **44**, **45** and bridges **46**. In addition, projections **123** on the rectangular flange **134** of the driven member **112** are connected to a second set of radial projections **124** on the intermediate member **113** by pairs of tensile breaking pieces **40**, **41** and bridges **42**. In like manner, radial projections **144** on the flange **134** of the driven member **112** are connected to radial projections **146** on the intermediate member **113** by pairs of reaction members **44**, **45** and bridges **46**. The pairs of tensile breaking pieces **40**, **41** connecting the driving member **111** to the intermediate member **113** are preloaded in tension as in the coupling illustrated in FIGS. **1** to **5** and are arranged to fail when the coupling is transmitting torque in one direction. The pairs of tensile breaking pieces **40**, **41** connecting the intermediate member **113** to the driven member **112** are similarly preloaded and arranged to fail when the coupling is transmitting torque in the opposite direction.

FIG. **10** illustrates a coupling having input-output elements **11**, **12** like the ones shown in FIG. **1**. However, a different breaking link assembly **400** is fitted over pins **29**, **37**. Assembly **400** comprises first and second ridged links **402**, **404** having holes **406**, **408** which are received over pins **29**, **37** respectively. Links **402**, **404** have end faces **410** **412** which abut so that the links **402**, **404** form the unitary assembly **400**. Links **402**, **404** have recesses **414**, **416** which receive the ends of a tensile breaking piece **418** extending through holes **420**, **422** in the links **402**, **404** respectively. Nuts **424** at the ends of breaking piece **418** are tightened against shoulders **426**, **428** in recesses **414**, **416** to place breaking piece **418** in tension.

If desired, additional links **430** may be provided to interconnect pins **28**, **36** and **30**, **38** to take up any slack between assembly **400** and the pins **29**, **37**. It should be noted, however, that the links **430** are not absolutely essential to operation of the present invention.

FIG. **11** illustrates an example of a production form of breaking link assembly **500** which embodies the present invention. Assembly **500** comprises a first rigid link **502** having an opening **504** to be received over a pin **501** in an overload protection coupling. Link **502** has an end face **506** having a cylindrical **508** recess therein from which a bore **510** extends to a recess **512**. A second rigid link **514** has a pair of pins **516** which are adapted to be received in a saddle **518** (shown in dashed lines) on the periphery of an overload coupling. Link **514** has an end face **520** abutting face **506** of link **502** and a cylindrical protrusion **522** piloted in recess **508**. A bore **524** extends through link **514** and is coaxial with bore **510** of line **502**.

A tensile breaking piece **526** has a necked down portion **528** adjacent end surfaces **506**, **520**. Piece **526** further comprises lands **530**, **532** which are respectively piloted in bores **510**, **524**. The end of piece **526** which is received in recess **512** has a threaded portion **534** over which a spherical nut washer combination **536**, **538** is positioned. The opposite end of piece **526** has a threaded portion **540** which receives a nut **542** sandwiching a hydraulic nut assembly **544** against link **514** to place breaking piece **526** in pre-tension. A U-shaped clip **546** has a slot **549** placed over the threaded portion **534** of piece **526** and is secured to the walls of recess **512** by screws **548**. A corresponding U-shaped clip **550** has a hole **552** through which threaded portion **540** extends. Clip **550** is held over the end of assembly **500** by screws **554**. The purpose of the clips **546** and **550** are to retain the portions of the tensile breaking piece **526** within the assembly after it is broken.

Although several preferred embodiments of the present invention have been described, it should be apparent to those skilled in the art that it can be practiced in other forms without departing from its spirit and scope.

Having thus described the invention, what is claimed as novel and desired to be secured by Letters Patent of the United States is:

1. An overload protection coupling for limiting the torque transmitted between two elements of a rotating power transmission system, said coupling comprising:

coaxial driving and driven members journaled for rotation relative to one another;

at least one tensile breaking piece positioned on the periphery of the overload protection coupling and comprising an elongated rod whose two ends are connected to respective projections on the driving and driven members, at least one end of the rod being screw threaded and carrying an adjustable nut enabling the projections on the driving and driven members to be displaced towards one another thereby urging relative rotation in a first direction; and,

a pretension means also positioned on the periphery of the overload protection coupling and comprising a tube disposed around each elongated rod and whose two ends abut the projections on the driving and driven members respectively to resist said displacement of the projections upon tightening of said adjustable nut thereby placing said tube in compression and pretension said tensile breaking piece up to a given level which is approximately equivalent to the maximum torque transmitted by said coupling.

* * * * *